BOARD # 341: Characterizing design activity engagement: Summary of insights from Year Three - NSFR RFE

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Elliott Clement is a doctoral student at Oregon State University. His current research is using grounded theory to understand identity and motivation within the context of capstone design courses. He is also part of a research team investigating context-specific affordances and barriers faculty face when adopting evidence-based instructional practices in their engineering courses.

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Dr. James Huff is an Associate Professor within the Engineering Education Transformations Institute and School of Electrical and Computer Engineering. He also serves as Deputy Editor with the Journal of Engineering Education and Chair of the Education Research and Methods Division in the American Society for Engineering Education. He earned his Ph.D. in Engineering Education from Purdue University, his M.S. in Electrical and Computer Engineering from Purdue, and his B.S. in Computer Engineering from Harding.

Dr. Huff is a qualitative researcher whose work lies at the interdisciplinary nexus of engineering education research and applied personality and social psychology. An NSF CAREER Awardee, he is committed to fostering care as a central mindset of engineering and other professions through his in-depth examinations of personal lived experiences of identity and emotion, facets often hidden within professional domains. As Principal Investigator of the Beyond Professional Identity lab, Dr. Huff has mentored undergraduates, doctoral students, and professionals from over fifteen disciplines in conducting their qualitative investigations on psychological phenomena relevant to equity and well-being in workplaces and degree programs.

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Abstract:
In this paper, we aim to highlight how understanding the factors influencing civil and mechanical engineering students' engagement in capstone design activities can affect course planning and translate to increased student engagement with capstone design activities. We build upon findings from previous studies as well as current work funded through the NSF RFE program exploring engineering students' engagement and motivation in capstone design activities.

Introduction:
Capstone design courses are an important part of engineering students' training as they expose students to complex engineering design problems and include aspects of professional engineering. These open-ended design courses are presented as a transitional step between student's academic and professional engineering careers [1], [2].

By understanding and improving student engagement in design activities within capstone courses, educators can develop and solidify students' engineering design skills and better prepare them for the transition into workplaces [3]. Little research has been done on the factors impacting student engagement in capstone design courses.

Summary of project objectives and research methods:
Similarly to our results from Year One [4] and Two [5] this study is linked to a larger study aiming to develop a model of design activity engagement and identity motives in students and professionals using Constructivist Grounded Theory (CGT) [6], and is informed by the concepts of situated cognition [7] and engagement with engineering practice [3].

The specific research-focused aims of this project are to:
Objective 1: Develop a model of design activity engagement and identity motives of students and professionals.
Objective 2: Expand our model to account for the resistance and synergies, alignment, and tension, between academic and workplace settings and across disciplines.

While results from year 1 focused on the viability of our semi-structured protocol, and results from year 2 provided further insights into our CGT coding process, the aim of this intermediate study is to explore how a novel theoretical framework of student design engagement could impact capstone course planning and lead to increased student engagement. Using our framework of design activity engagement developed through a grounded theory study founded

by the NSF RFE program, we explore how our theoretical understanding of student engagement could be implemented throughout the development and implementation of capstone courses.

Summary of Results:
Our larger CGT study reveals that 3 aspects of capstone courses strongly impact students' design engagement: feedback, design processes, and design outcomes. These 3 processes are intrinsically linked to processes of identity affirmation leading to further engagement. While we will not describe these findings in depth in this paper, we can reflect on the useability of these results from a pedagogical standpoint, more specifically, how capstone courses could be planned and operated to take our findings into account.

Firstly, the purposeful inclusion of qualified feedback (feedback provided from a source with expertise relating to the student's task within the capstone course) throughout the duration of the capstone course was shown to be beneficial to student engagement. This suggests that implementing activities such as professional design reviews or peer reviews may help sustain student engagement in the capstone course.

Secondly, establishing requirements for technical design work from students across the duration of the capstone project can help students stay engaged. Students frequently reported that a low amount of design work led them to consider the course as "busy work" and significantly impacted their motivation and engagement.

Lastly, ensuring that students' design ideas are implemented throughout the project showed to foster engagement in the design process. Indeed, students who reported feeling a sense of agency over the design were also consistently engaged and active in the project's progress.

Discussion:
These results constitute a knowledge base upon which further research on engagement and motivation within capstone courses can be expanded. In addition, our findings could be used by capstone educators as a starting point in adapting and developing course activities and structure focused on fostering student design activity engagement. Expansion to different engineering fields and further considerations of professional engineering engagement will be needed to expand our understanding of motivation in design activity engagement and reach more fields and settings.

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